NASA TECH BRIEF

NASA Headquarters

Metabolic Simulation Chamber

The problem:

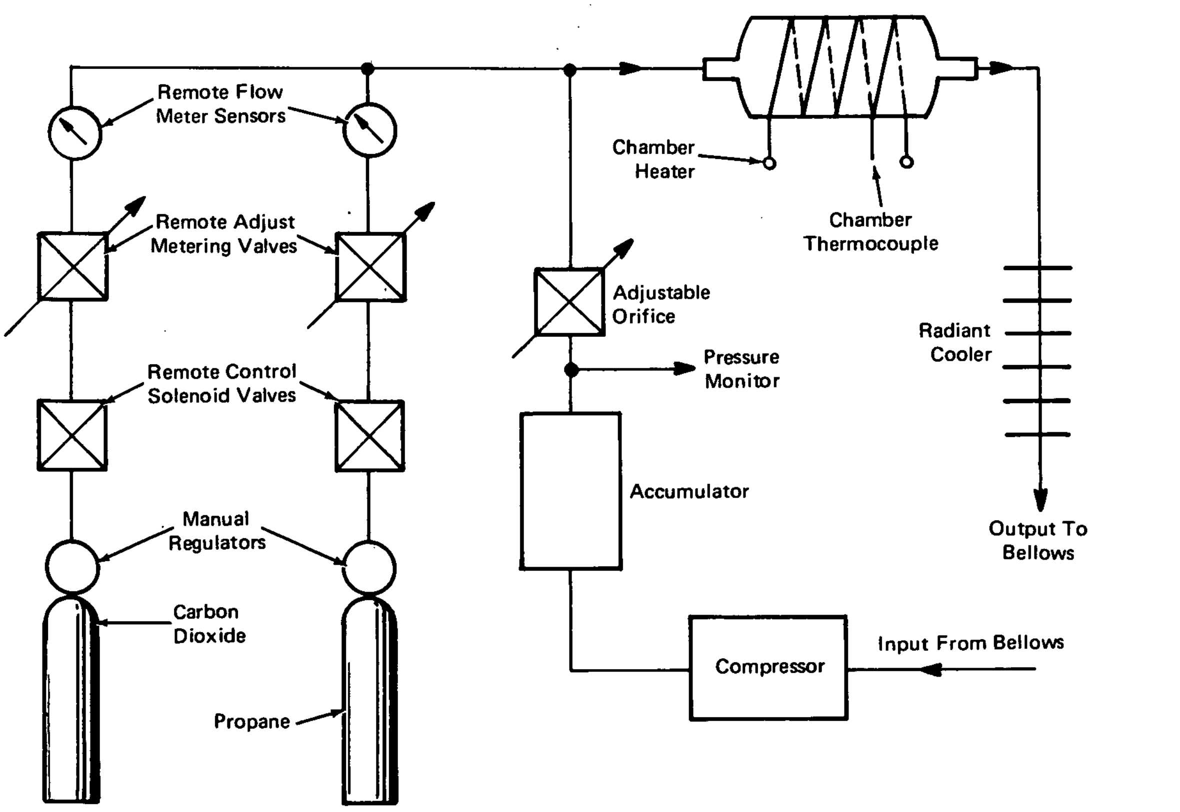
In evaluation of life support equipment, it is often necessary to simulate a range of metabolic rates that are identical to those of the human subjects. Simulation of metabolism involves the reproduction of air which is identical in chemical composition to that of the air exhaled by the humans. Advantages of simulated metabolism compared with those of human subjects include a consistent performance, a rapid selection of desired metabolic rates, and use in environments which may be dangerous to humans.

The solution:

A metabolic simulation combustion chamber has been developed as a subsystem for the breathing metabolic simulator (see Notes). The entire system is used in evaluation of life support and resuscitation equipment.

How it's done:

The metabolism subsystem, as shown in the figure, simulates a human by consuming oxygen and producing carbon dioxide. Its basic function involves oxidation of propane gas by air and addition of CO_2 in various



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proportions to simulate human metabolic range from rest to hard work.

In operation, the subsystem uses a quartz combustion chamber which is 30 cm (12 in.) long with a centered main body having a length of 15 cm (6 in.) and a 3.18 cm (1.25 in.) outside diameter. The chamber is connected to gas lines through flexible stainless steel vibration isolators and is surrounded by a two-piece insulated electrical heating element. Each half of the element requires 375 watts and is energized continuously in normal operation. The incoming gases consist of propane, air, and carbon dioxide at a normal temperature and the desired ratio. This ratio is always sufficient to provide enough oxygen for complete propane oxidation. As the gases enter the chamber they are mixed by encountering the tubing segments, and as they progress through the chamber, their temperature is raised in excess of the normal propane ignition temperature of 741K (875°F). Normal operation, depending on flow rates, involves a temperature range of 978 to 1048K (1300 to 1425°F), as measured by a thermocouple located in the well at the output end, which completely oxidizes the propane.

The metabolic simulation combustion chamber has several features. First, its design permits an external heater to maintain an internal temperature in excess of the normal propane ignition temperature over a wide range of gas flow rates. Thus, metabolic simulation is achieved over a wide CO_2/O_2 ratio range simply by varying the input CO_2 and the propane flow rates. And second, the design contains provision for a thermocouple to monitor temperature within the combustion chamber. This permits remote verification of the desired temperature and also the use of a temperature safety monitor to automatically shut-off propane flow in the event that temperature falls below the preset nominal temperature of 811K (1000°F).

Notes:

1. Additional information is contained in the following Tech Briefs: B72-10657 (HQN-10766), B72-10659 (HQN-10777), B72-10660 (HQN-10778), and B72-10661 (HQN-10779).
2. Requests for further information may be directed to:
   Technology Utilization Officer
   NASA Headquarters
   Code KT
   Washington, D. C. 20546
   Reference: B72-10658

Patent status:

NASA has decided not to apply for a patent.

Source: R. G. Bartlett and C. M. Hendricks of IBM Corp.
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